

over this human path and make processions many yards beyond this path, but they were not permanent trackways.

The number of trackways varied with the nest (or mouth-opening) but only three of them had no branches; one of these was from nest E and the other two were from nest F, all the rest having a varying number of branches. The longest of these trackways was the one running in a northern and westerly direction from nest-mouth F; this was 57 feet long and stretched from its point of origin at F to near nest-mouth A at X. Trackways from nests C, D and E crossed this track at various points along its course and in the neighbourhood of F there was quite a "maze" of tracks running in different directions. Processions of ants along any one of these tracks kept rigidly to it and did not go off along a different track because that particular track crossed another one.

In order to show more clearly how these permanent trackways show up in the grass a photograph of the tracks leading from a nest of *M. b. barbarus* was taken. This is shown in the accompanying photograph (Fig. 2). This nest was situated some 30 yards or so to the north-west of the area described above. This particular nest was situated amongst the roots of a small spinous shrub about 2 ft. to 2 ft. 6 ins. in height. The trackways led chiefly in an easterly direction, the pathway in the photograph being a continuation of the pathway marked on Fig. 1. In this photograph three ant-trackways are plainly to be seen (marked A, B and C) as lighter coloured lines running from the nest towards the human pathway. Track C divided at the point C into two branches marked C1 and C2.

REFERENCE.

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CHANGES IN THE DISTRIBUTION AND ABUNDANCE OF THE LEPIDOPTERA.

By BRYAN P. BEIRNE, Ph.D., M.R.I.A., F.R.E.S.

One of the neglected aspects of the study of the Lepidoptera is the causes of changes in the distribution and abundance. Many such changes can be attributed, either directly or indirectly, to the weather or to human activities. Some other causes, all of which require further investigation, are discussed below.

Little is known of the causes of great outbreaks of larvae. While every species fluctuates in abundance from year to year, there are some whose larvae occur occasionally or regularly in vast numbers. There is one significant fact in connection with the majority of these species: their habits are such that there is normally a tendency for heavy concentrations of larvae to arise in limited areas. With some the females are incapable of flight so that each normally must lay all its eggs in a limited area on a single tree, examples being *Orgyia antiqua*, *Operophtera brumata*, *O. fagata*, *Phigalia pilosaria* (*pedaria*), *Erannis defoli-*

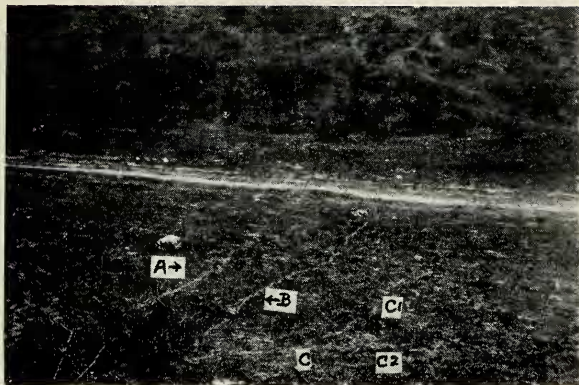


Fig. 2. Photograph of the permanent trackways leading from a nest of *M. b. barbarus*: these are marked A, B and C. C1 and C2 represent branches of the track C.

aria, *E. leucophearia*, *E. aurantiaria* and *Alsophila aescularia*. In other cases the eggs are laid in batches and the larvae live gregariously in large colonies, examples being *Euphydryas aurinia*, *Euproctis chrysorrhoea*, *Malacosoma neustria*, *Eriogaster lanestris* and the Hyponomeutidae. This tendency, however, does not appear to be present in other species amongst which great outbreaks occur, namely *Philudoria potato-ria*, *Macrothylacia rubi* and *Charaeas graminis*.

A possible explanation for the outbreaks of species whose larvae tend to occur in heavy concentrations is that they are normally kept in check mainly by one particular type of natural enemy. Occasionally a colony of larvae escapes attack so that instead of only a small proportion reaching the adult stage the majority do so. The result is that in the following year the species becomes enormously abundant in that area.

In the case of the Hyponomeutidae there are indications that birds are the chief natural enemy. Normally an average of over 95% of the larvae appear to be eaten by birds but occasionally some colonies are overlooked so that instead of about 2% reaching maturity about 40% do so, the remaining 60% being destroyed by other natural enemies (Beirne, *Econ. Proc. R. Dublin Soc.*, III: 191). The result is that if only a single colony escapes attack the species is about twenty times more abundant in a limited area in the following year, while if several colonies escape this figure is multiplied proportionately.

Possibly birds are the chief natural enemies of *O. antiqua*, as outbreaks of this species seem to occur chiefly in towns where birds are relatively scarce; the ova, rather than the larvae, may be attacked. Parasitic Hymenoptera appear to be the chief enemies of *E. aurinia*. The chief enemies of the remaining species are not known and their identities require investigation. In all cases the enemy whose absence is responsible for the outbreaks probably is one which attacks the eggs or the larvae of those species which live gregariously or the females or eggs of those whose females are wingless. Climatic factors are doubtless of great importance in many cases and information is required on their identities, on whether they affect the species directly, i.e., by killing the females, ova or larvae, or indirectly, i.e., by influencing the degree of attack by the natural enemies.

It is difficult to suggest possible causes of outbreaks of larvae of *P. potato-ria*, *M. rubi* and *C. graminis*. But it may not be coincidence that the two most severe outbreaks of *C. graminis* in the past century occurred in areas in which great vole outbreaks took place a few years previously. The two greatest vole outbreaks of recent times took place in the Southern Uplands of Scotland in 1875-6 and 1891-2 (Elton, *Voles, Mice and Lemmings*), while the outbreaks of *C. graminis* just mentioned took place in almost exactly the same areas in 1885 and 1894. However, Dr Elton informs me that there are no records of vole outbreaks preceding other recorded outbreaks of *C. graminis* larvae. Nevertheless, this is a point requiring investigation.

Possibly outbreaks of *P. potato-ria*, *M. rubi* and *C. graminis* may be due to similar causes as judging from the published records they seem to occur mainly on heathy grasslands or hill pastures with all three species.